Pleistocene Margin Stratigraphy, New Jersey *vs.* Northern California: A Strataform Study of Contrasts

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LONG-TERM GOAL

The goal of STRATAFORM is to link short-term biological and physical processes affecting sedimentation ("event" stratigraphy" developed over hours to weeks) to the stratigraphic geometry and facies distribution of the upper ~100 m of continental margin sediments representing ~10^6 years of preserved record.

OBJECTIVES

Three groups of processes have been isolated for study by STRATAFORM investigators: 1) shelf sediment dynamics and the development of lithostratigraphy; 2) slope processes and their role in shaping geomorphology; and 3) stratigraphic sequence generation. Collecting high-resolution seismic reflection data as we have done is at the core of this third approach. All three are linked by our goal of determining how the morphology and facies patterns of the modern sea floor (revealed by multibeam bathymetry, backscatter data, and sampling of the shelf and slope) compare with the preserved geologic record observed in seismic images and sampled in the subsurface.

APPROACH

With funding from ONR and other sources, Lamont-Doherty assembled equipment to meet the STRATAFORM requirements of high-resolution reflection profiling. This included a generator-injector ("GI") airgun, towing harness, and shot control system, a 2000 psi diesel-powered compressor, a 48-channel 600-m narrow-gauge (solid, not oil-filled) analog streamer with depth-control birds, and a digital recording system capable of the moderately high sampling rates (0.5 msec) required for ~5m vertical resolution of sub-seafloor images. Existing profiles showed that a track spacing of 2 to 5 km on the New Jersey margin was sufficient to map the comparatively uniform stratigraphy of that passive margin; a 950 nmi survey was completed on cruise Oc270 in July, 1995. Structural complexities off northern California, by contrast, required line spacing of 800 m and less; a 1200 nmi grid on cruise W9605 was completed in July, 1997. Both seismic surveys were designed to: cover areas previously mapped with swath bathymetry and acoustic backscatter; tie to available seafloor samples; and duplicate several profiles of lower resolution (air gun) and higher resolution (Huntec) imaging. This "nested" data

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set allowed us to optimize the information provided by each acquisition system and provide a more complete understanding of processes shaping the geologic record along both continental margins.

WORK COMPLETED

The YR I goal of finishing all processing of Oc270 seismic profiles has been met, and all but 3 lines (out of 166) have been exchanged with Co-PIs at the University of Texas at Austin. The L-DEO team is now on schedule for completing by the end of YR II the processing of all W9605 data and similarly exchanging each line with Austin colleagues. We intend to make isopach and structural contour maps of key sub-seafloor reflectors along both margins. Tracings of Pleistocene reflectors in the Oc270 data set have been done and we are currently evaluating the merits of either digitizing these from the paper displays, or loading all data into a seismic workstation and mapping entirely in electronic form. Because most of the available seismic data until now are from the New Jersey margin, and because these can be tied to ODP drillsites that were sampled and logged during Legs 150 and 174A, correlations to the rock record are currently restricted to New Jersey.

RESULTS

Integration of core, seismic, and well-log data during YR I has provided improved understanding of the sediment record at ODP Site 1073 and of Oc270 profiles collected along the slope and outer continental shelf of New Jersey. Erosional truncation, basal downlap, and clinoform rollovers have been used to identify 4 Late Pleistocene depositional sequence boundaries that are candidates for times of eustatic sea-level lowerings. It appears that very little sediment transported offshore during sea-level lowstand was retained on the outer margin; it was probably transported to the continental rise through an efficient canyon network. Furthermore, the especially wide and gently dipping New Jersey shelf provided a large depocenter during sea-level rise, ensuring that the outer margin continued to be starved of sediment until late in the sea-level cycle. Consequently, we expect late high-stand sediments to dominate the slope record. Ties to ODP Site 1073 support these preliminary interpretations, but detailed chronostratigraphic control must await parallel studies by ODP-supported scientists and from additional coring efforts on the shelf and slope.

IMPACT /APPLICATIONS

The ocean record of stable oxygen isotopic variations shows that global ice budgets varied on roughly 20-ky cycles for the entire Pleistocene. Ironically, our analysis offshore New Jersey reveals only 4 demonstrable falls in sea level in the last ?500 ka. This conflict raises the concerns about the level of detail that is preserved in continental margin sediments, i.e., why do we see what appears to be only 1 in 5 sea level changes, and for that matter, what removed the entire record between 500 ky and 2 my? Furthermore, we observe many erosional surfaces beneath the slope that attest to massive sediment failure events. Many of these removed middle and lower slope sediment only, leaving the upper slope relatively intact and arguing against sea-level change as the fundamental cause. Our studies demonstrate that unraveling a sea-level record in slope sediments is a very difficult and complex task.

TRANSITIONS

Maps of sediment thickness and structural features off both New Jersey and northern California will be made available to all STRATAFORM investigators. We have matched these data to other acoustic records (HUNTEC, lower resolution airgun profiles, etc.) and have developed a coring strategy to

ground-truth these data and address the primary STRATAFORM issue of how well the event-scale features of the seafloor are preserved in the geologic record.

RELATED PROJECTS

STRATAFORM investigators are in regular communication, pursuing parallel and complementary studies. Data will be exchanged between all investigators when complete. For example, M.Field and colleagues (USGS) have a similar project evaluating finer-scale histories of sediment geometries off Eel River using Huntec technology; J.Austin and colleagues (UTIG) are doing similar interpretations of HUNTEC data off New Jersey. The combination of Hi-Res MCS data along overlapping track lines on both margins will provide a unique and valuable assessment of sediment processes at a wide range of scales. M. Steckler (L-DEO) and colleagues are modeling depositional geometries on both margins, and our profiles will provide them with valuable ground truth. We anticipate especially unique insights to be gained by incorporating the effects of Pleistocene ice loading on the New Jersey margin J.Goff (UTIG) and colleagues have prepared a seabed backscatter map on both margins and will be examining correlations between their findings and sub-bottom facies and structure that our profiles reveal. James Syvitski (Colorado) and colleagues are examining factors that destabilize slope sediments, and the history of mass wasting revealed by our profiles will be a valuable long-term record.

PUBLICATIONS

M.S. Steckler, G.S. Mountain, K.G. Miller and N. Christie-Blick, *in press*,
Reconstructing the geometry of Tertiary sequences on the New Jersey passive margin by 2-D backstripping: The interplay of sedimentation, eustasy and climate; *Marine Geology*